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BNL-82225-2009-CP

Moving toward multilateral mechanisms for the fuel cycle

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INMM 50th Annual Meeting
Tucson, Arizona
July 12-16, 2009

Nonproliferation and National Security Department
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DISCLAIMER

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ABSTRACT: Multilateral mechanisms for the fuel cycle are seen as a potentially important way to create an industrial infrastructure that will support a nuclear renaissance and at the same time not contribute to the risk of nuclear proliferation. In this way, international nuclear fuel cycle centers for enrichment can help to provide an assurance of supply of nuclear fuel that will reduce the likelihood that individual states will pursue this sensitive technology, which can be used to produce nuclear material directly usable in nuclear weapons. Multinational participation in such mechanisms can also potentially promote transparency, build confidence, and make the implementation of IAEA safeguards more effective or more efficient. At the same time, it is important to ensure that there is no dissemination of sensitive technology.

The Russian Federation has taken a lead role in this area by establishing an International Uranium Enrichment Center (IUEC) for the provision of enrichment services at its uranium enrichment plant located at the Angarsk Electrolysis Chemical Complex (AECC). This paper describes how the IUEC is organized, who its members are, and the steps that it has taken both to provide an assured supply of nuclear fuel and to ensure protection of sensitive technology. It also describes the relationship between the IUEC and the IAEA and steps that remain to be taken to enhance its assurance of supply.

Using the IUEC as a starting point for discussion, the paper also explores more generally the ways in which features of such fuel cycle centers with multinational participation can have an impact on safeguards arrangements, transparency, and confidence-building. Issues include possible IAEA safeguards arrangements or other links to the IAEA that might be established at such fuel cycle centers, impact of location in a nuclear weapon state, and the transition by the IAEA to State Level safeguards approaches.

1. Background

There is widespread support for a future in which the use of nuclear energy is a growing component of the world's energy production, but in which, at the same time, the spread of sensitive nuclear technologies – and thus the risk of proliferation – is minimized. A key element of achieving these objectives is the development of mechanisms to provide nuclear fuel to customers at competitive prices and an assurance of supply so robust that they have no economic or energy security incentives to pursue indigenous enrichment or reprocessing programs. Multilateral approaches to the nuclear fuel cycle are an important means to create such a mechanism.

Such multilateral approaches have already received considerable review and attention. For example, in 2004 the IAEA Director General appointed an international group of

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experts to consider their potential.[i] At the Eurasian Economic Community summit in January 2006, the President of the Russian Federation, V.V. Putin, made a statement[ii] on the peaceful use of atomic energy in which he noted the need for the establishment of a global nuclear power infrastructure, ensuring equal access to nuclear power for all interested parties and, at the same time, reliable compliance with the requirements of the non-proliferation regime. A key element of such an infrastructure, he said, should be the creation of a system of international centres providing nuclear fuel cycle services, including enrichment, under the control of the IAEA. The main assurance that the initiative should provide is that a country complying with its non-proliferation commitments must be sure that, whatever the turn of events, whatever changes take place in the international situation, it will receive the services guaranteed to it.

More recently, President Obama, while he was a candidate, issued a Fact Sheet,[iii] which addressed the issue of fuel assurances as follows:

> Prevent Nuclear Fuel from Becoming Nuclear Bombs: Barack Obama will work with other interested governments to establish a new international nuclear energy architecture - including an international nuclear fuel bank, international nuclear fuel cycle centers, and reliable fuel supply assurances - to meet growing demands for nuclear power without contributing to the proliferation of nuclear materials and fuel production facilities.

The Russian Federation has taken a lead role in establishing an international nuclear fuel cycle center for the provision of enrichment services. In particular, it has created an International Uranium Enrichment Center (IUEC) at its enrichment plant at the Angarsk Electrolysis Chemical Complex (AECC). In a communication to the IAEA Director General in June, 2007,[iv] the Russian Federation highlighted important aspects of international nuclear fuel cycle centers and the IUEC, including;

- Nondiscrimination within the NPT: A global nuclear power infrastructure to ensure equal access to nuclear power and, at the same time, reliable compliance with the requirements of the non-proliferation regime.
- IAEA participation: A system of international centers providing nuclear fuel cycle services, including enrichment, under the control of the IAEA.
- Assurance of supply: A guarantee that for a country complying with its non-proliferation commitments it will receive the services guaranteed to it regardless of events or whatever changes take place in the international situation,
- Protection of technology: No transfer to IUEC participants of uranium enrichment technology or information that constitutes a State secret.
- Safeguards: Making the IUEC eligible for safeguards under Russia's voluntary offer safeguards agreement
- Uranium reserve: setting aside a specific quantity of enriched uranium product as a deposit for a guaranteed stockpile at the IUEC in a quantity of up to 1-2 full reactor loads; and a regulatory basis such that the shipment of material out of the country at the request of the Agency is guaranteed.
- Advisory body: establishment of a joint advisory committee with the presumption that the IAEA will be represented in the committee.

All in all, the IUEC contains elements that many observers have considered important for multilateral nuclear arrangements: accessibility, assurance of supply when there is compliance with nonproliferation commitments, IAEA safeguards, and a uranium reserve to provide a physical "fuel bank" to underscore the assurance of supply.

2. Status of the IUEC

2.1 The Russian initiative to establish an international centers network under IAEA control

In accordance with the statement of President Putin noted above, the objectives of the Initiative are to:

- prevent an uncontrolled proliferation of sensitive nuclear technologies that could be used not only for civil but also for military purposes;
- increase the role of nuclear energy in provision of global energy assurance;
- develop the global nuclear energy infrastructure via the establishment of an international nuclear fuel cycle centers network; and
- provide non-discriminatory and assured access to products and services of the nuclear fuel cycle for those states that are currently developing nuclear power.

While the Russian President's Initiative suggested that four types of centers could be created, uranium enrichment; reprocessing of spent fuel; training of personnel for the nuclear industry; and development of innovative atomic energy technologies, it was decided to launch first a pilot project to establish the International Uranium Enrichment Centre (IUEC) on the site of the Angarsk Electrolysis Chemical Complex (hereinafter the AECC) taking into account the developed infrastructure there. This was announced in September 2006 by Rosatom at the 50th session of the IAEA General Conference.

The IUEC was established in partnership with the Republic of Kazakhstan as a joint-stock company. This structure ensures the IUEC's financial independence from the State budgets of the participants. The main function of the IUEC is to provide its participating companies with guaranteed access to uranium enrichment capabilities. At the same time, the Russian side will not transfer to IUEC participants the sensitive uranium enrichment technology or classified information that constitutes a State secret.

In addition, on 27 December, 2007, the Government of the Russian Federation took the decision to include the IUEC on the list of Russian facilities that could be subject to the IAEA Safeguards in the framework of the Safeguards Agreement between Russian Federation and the IAEA - INFCIRC/327. The Russian Government decided that in case of IAEA safeguards application to IUEC nuclear material, the costs of safeguards would be covered by the Russian Federation. As of early 2009, arrangements to put IUEC nuclear material under IAEA safeguards were under negotiation.

2.2 Intergovernmental Agreement

The Agreement between the Governments of the Russian Federation and the Republic of Kazakhstan about the establishment of the IUEC sets forth the fundamental basis for its goal, structure, and governance, including:

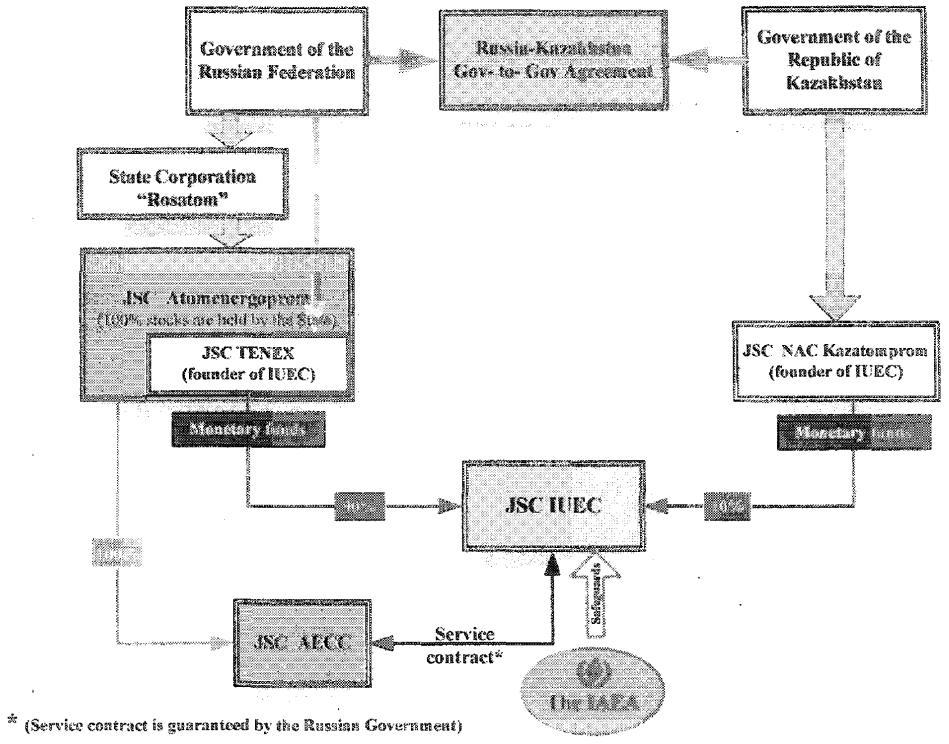
- Main goals and terms for the IUEC operations;
- Executive bodies and authorized companies;
- Form of incorporation and location of the IUEC ;
- Basic requirements to member-countries (in full compliance with their NPT obligations), whose nominated companies would become shareholders of the IUEC;
- Provision that there be no access by foreign shareholders to the Russian uranium enrichment technology and classified information;
- Application of IAEA safeguards to IUEC nuclear materials;
- IAEA participation in the work of IUEC' Joint Consultative Commission established for the effective implementation of the objectives of the Agreement. As may be agreed with the IAEA, the representative from the IAEA may participate in the work of the Commission being entitled to the consultative capacity.

2.3 The structure of the IUEC

The structure on foundation of the IUEC is shown in **Figure 1.**

The initial Intergovernmental Agreement between Russia and Kazakhstan entered into force in August, 2007. It nominated JSC TENEX and JSC "NAC Kazatomprom as founders of the IUEC. It was then also established in August 2007 in the form of a Joint-Stock Company (JSC). The initial share distribution was: JSC TENEX - 90% and JSC "NAC Kazatomprom" - 10%. The IUEC then concluded service contracts with the AECC.

Figure 1.



2.4 The IUEC basic principles

Article 3 of the Agreement between the Russian Federation and the Republic of Kazakhstan establishes the main task of the IUEC as securing assured access to the uranium enrichment capacities of the AECC for organizations-participants of the Center from countries that do not develop their own uranium enrichment capacities.

The IUEC basic principles are:

- Non-discrimination, i.e. equal membership terms for all States concerned;
- Assured access of the IUEC member-States to enriched uranium product (EUP) and/or SWU;
- The IUEC operation is based on the existing market relations;
- Transparency of the IUEC operation through the application of IAEA safeguards to nuclear material under the ownership of the Center;
- No access of foreign members to the Russian uranium enrichment technology and classified information;
- Advantages of IUEC to its member-countries through guaranteed access to goods and services (EUP/SWU) will exceed any benefits that might be obtained by developing and relying on their own sensitive nuclear fuel cycle facilities.

2.5 Background of the IUEC foundation

Subsequently membership in the IUEC has grown. In November, 2007 the Republic of Armenia nominated the JSC "Armenian NPP" to join. On 24 June, 2008 the Republic of Ukraine made a decision to nominate the concern "Nuclear Fuel of Ukraine" to join the IUEC.

2.6 Maintenance of a guaranteed physical reserve as a second direction of the IUEC activity

In response to the IAEA Director General's initiatives on multilateral approaches to the nuclear fuel cycle and on assurance of fuel supply mechanisms, the Government of the Russian Federation has proposed to establish a guaranteed physical reserve of 120 tones of LEU. This will be in the form of UF6 with an enrichment level ranging from 2.0% to 4.95% and will be stored at the IUEC under Agency safeguards for the use of IAEA Member States experiencing a disruption of LEU supply. The costs of safeguards will be covered by Russia.

This LEU reserve would constitute a practical application of the provisions of Article IX of the Statute of the IAEA on the supply of nuclear material. The LEU reserve at the IUEC would be intended to serve as a guaranteed supply to supplement the existing commercial market in nuclear fuel and as a protection of interested Member States against possible disruptions of LEU supplies.

For a Consumer State to receive nuclear material from this reserve, the IAEA would have to draw a conclusion that all nuclear material had been accounted for; that there was no indication of diversion of declared nuclear material; and that there would not be any safeguards implementation issues concerning the State under consideration by the IAEA Board of Governors. The LEU would be made available to any non-nuclear-weapon State member of the IAEA that has an effective safeguards agreement with the IAEA requiring the application of safeguards on all of its peaceful nuclear activities.

Important features of the LEU Reserve at the IUEC include:[v]

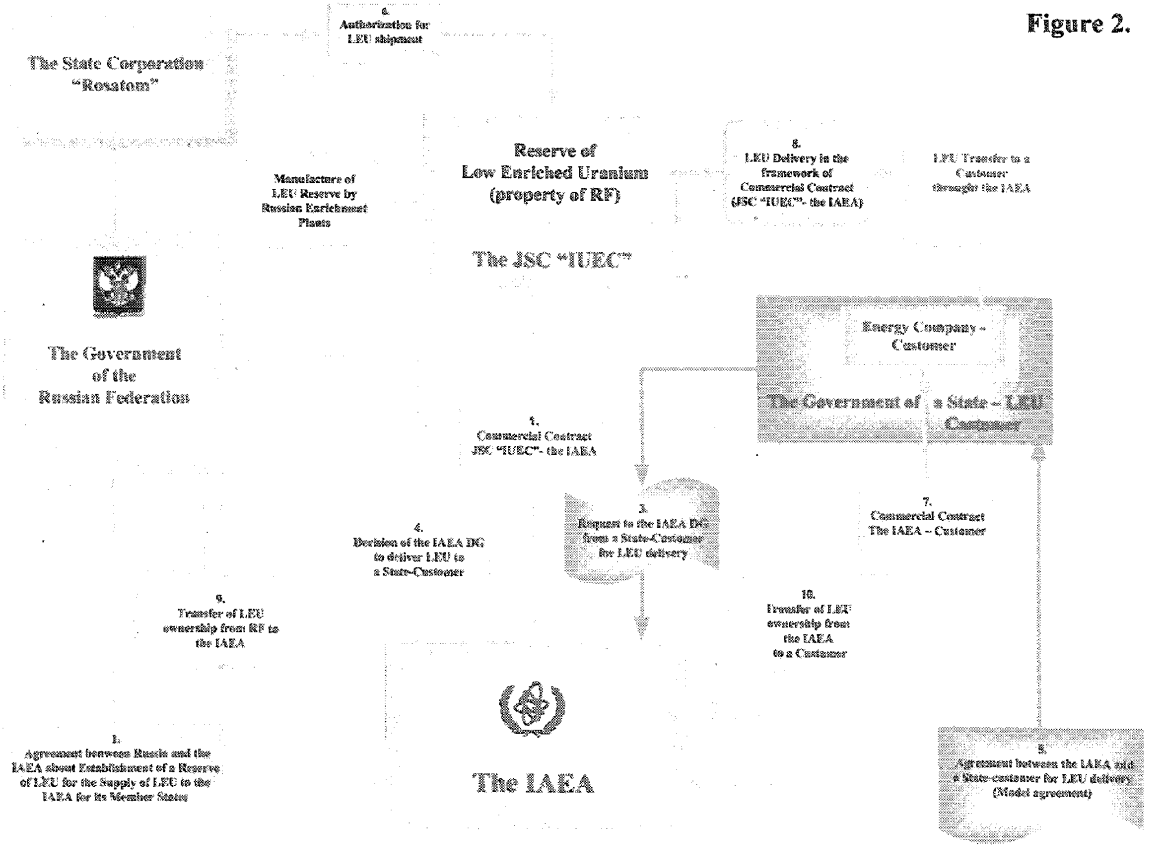
- **Non–discriminatory and inclusive nature** – it would be available to all IAEA Member States meeting the above-mentioned attributes;
- **Non-restrictive** – there would be no requirement for interested IAEA Member States, explicit or implicit, to forgo any rights, including rights to develop a country's national fuel cycle capabilities;
- **No cost to the IAEA** – there would be no financial burden on the IAEA or its Member States, since all start-up, storage, maintenance, safeguards and other costs would be covered by Russia; the cost of any LEU supplied from the reserve would be covered by the Consumer State at the time of delivery;
- **Non-exclusive** – it would not conflict with or hinder the establishment or operation of any other elements of assurance of supply mechanisms;
- **Non-disruptive** – the LEU reserve would not undermine the commercial nuclear fuel market; the quantity of LEU delivered would be relatively small compared to

the overall market volume, and the actual market spot price would be charged to the Consumer State;

- **No delays** – the Government of the Russian Federation in its agreement with the IAEA on establishing an LEU physical reserve would confirm that all necessary authorizations and export licenses would be issued and that the LEU could be exported without undue delay for supply to a Consumer State;
- **Pro-cooperative** – it would work in synergy and harmony with various initiatives on nuclear fuel supply assurances, current and future, and contribute to a menu of other fuel assurance options that may be agreed upon by IAEA Member States, such as for example the IAEA LEU bank proposed by the Nuclear Threat Initiative, as well as the multilateral enrichment sanctuary project (MESP) proposed by Germany;
- **Prolonged** – it would be established for an indefinite period and replenishment of the supply of LEU is envisaged;
- **Promotional** – it would facilitate the continuing and future use of nuclear energy for electricity production, and support its beneficial expansion to help meet increasing global energy needs.

A flow chart of establishment and utilization of a Reserve of LEU for the Supply of LEU to the IAEA for its Member States is shown in **Figure 2.**

Figure 2.



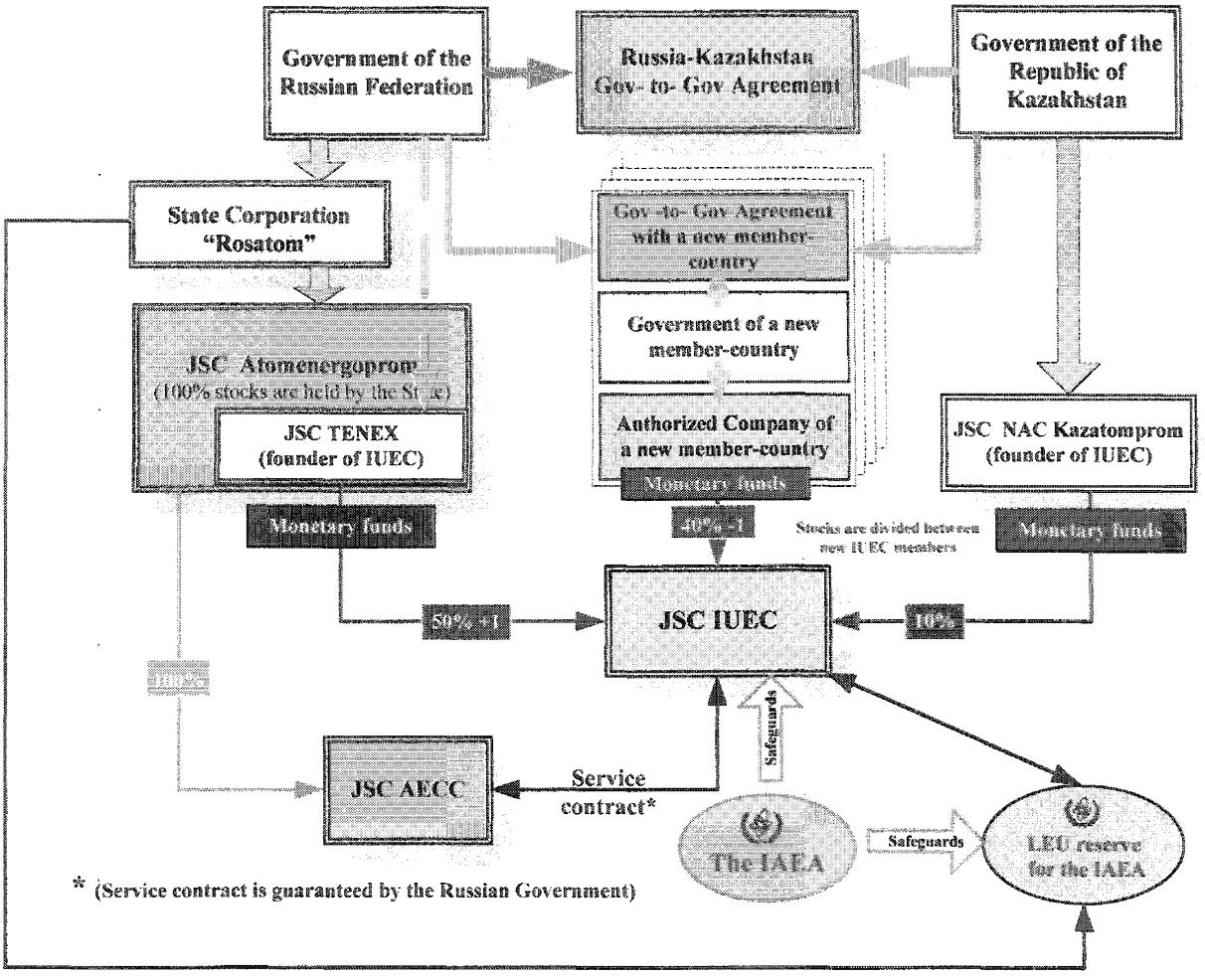
2.7 Membership of the IUEC

At the 52nd session of the IAEA General Conference held in Vienna in September 2008 Sergey Kirienko in his Statement[vi] said that, "...Membership of the Centre was open to other countries, without any political conditions...."

A complete structure of the IUEC is shown in **Figure 3.**

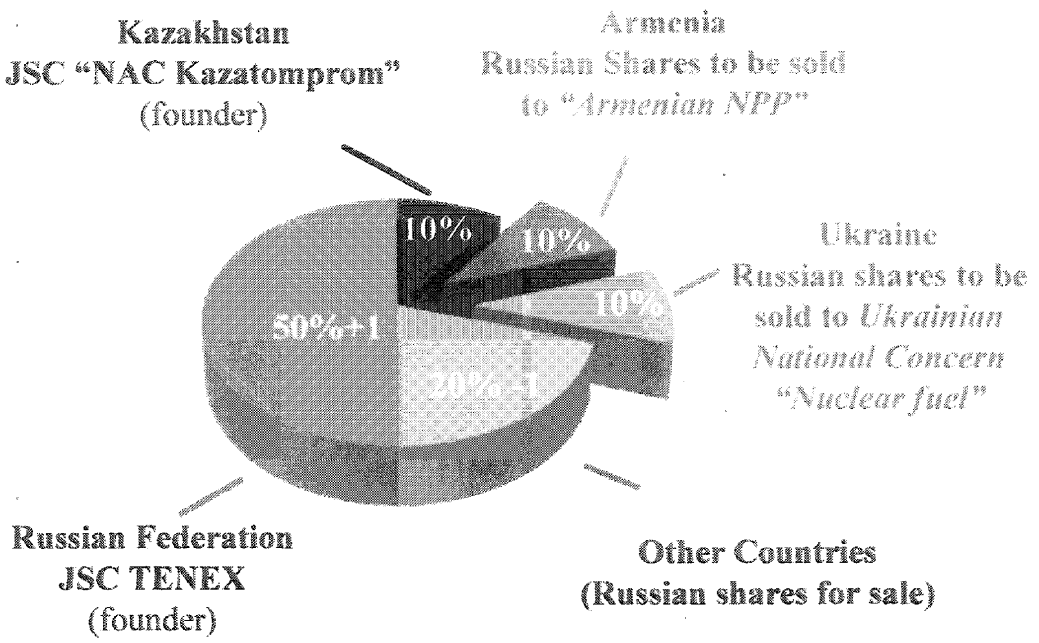
- Authorized Companies of new member-countries can join the IUEC on the basis of separate Government- to- Government Agreements.
- Article 5 of the Agreement on foundation of the IUEC says:
  - "...Such participation is carried out based on separate government-to-government agreements between the Parties hereto and governments of the third States in the manner prescribed in the Articles of Association of the Center..."
- As new members join, there is a redistribution of shares in the IUEC chartered capital that is obtained by reducing JSC TENEX share fraction as follows:
  - JSC TENEX - 50% +1 Share
  - JSC "NAC Kazatomprom" - 10%
  - New member-countries (all together) - 40% -1 Share

Figure 3.



The redistribution of shares in the IUEC chartered capital by reducing the JSC TENEX share fraction after the Republics of Armenia and Ukraine joined the IUEC is shown in **Figure 4.**

Figure 4.



3. Multilateral Mechanisms

The IUEC should be seen as part of a growing trend to develop multilateral mechanisms to underpin growing interest by many states in beginning or expanding nuclear power programs. Such mechanisms can lend confidence to the market and create an improved nuclear nonproliferation environment.[vii] However, the model adopted for the IUEC is not necessarily applicable in other circumstances. For example, the uranium feed purchased by the IUEC participants may not have associated with it the "label" or "flag" of another country or countries. Such flags generally carry with them requirements for retransfer that go beyond the requirements of full-scope safeguards and IAEA assurance of a positive safeguards status, as described above for the IUEC.

Further, each state or group of states desiring to create a multilateral mechanism will need to define for itself numerous features of it structure and operation, including for example: its business structure; ground rules for countries to participate; conditions of supply in routine circumstances and when a supply disruption is alleged; role(s) of IAEA other than safeguards; protection of sensitive technology; and means to promote transparency.

Nonetheless, using the IUEC as a starting point, it is worth exploring the ways in which features of nuclear fuel cycle centers with multinational participation can have an impact on transparency, confidence-building, and safeguards arrangements. Issues include possible IAEA safeguards arrangements or other links to the IAEA that might be established at such fuel cycle centers, impact of location in a nuclear weapon state, and the transition by the IAEA to State Level safeguards approaches.

3.1. Safeguards arrangements

Many observers envision that the safeguards arrangements at multinational nuclear facilities would differ from those employed in a comparable national facility. For example, the expert group report cited above (INFCIRC/640) suggested that, "With respect to MNAs, safeguards implementation by the IAEA should take into account the special positive nature of a multinational nuclear facility," with the rationale that:

- "Participants, whether private or governmental, would be committed to transparency and openness through the continuous presence of a multinational staff; and
- Flows of materials would be mostly between partners to the MNA.

The Experts suggested that "This additional layer of international oversight would be recognized by the IAEA, possibly allowing thereby a reduction of the safeguards verification effort." Indeed, if the IAEA were to receive "through the continuous presence of a multinational staff" additional confidence that the operation of the facility had been normal and correctly and fully reported, it would be reasonable for the IAEA to take this into account, for example, by reducing the detection probabilities that it used for planning inspections.

The Experts also cited the SAGSI May 2004 report which "noted that a large number of facilities receive nuclear materials from, and send nuclear materials to, other States, and also that many facilities employ multinational staff whose activities are interrelated with those of other States." They noted that, "SAGSI confirmed that the IAEA should give appropriate recognition to international interdependence under the so called 'State level approach,' an approach that would include consideration of State specific factors such as the level of cooperation with the IAEA on safeguards implementation in the State, including consideration of openness and transparency; and the presence of a supportive and effective State System of Accounting for and Control (SSAC) of nuclear material." This context, the Experts observed, is relevant for MNA joint facilities.

It would be for the IAEA to determine whether its confidence was enhanced by the nature of the MNA. At issue would be the extent of the information, its credibility, and how the IAEA would take it into account in modifying its safeguards approach. IAEA participation in an advisory board for the fuel cycle center, as is provided for in the IUEC, might benefit this process. Consideration might also be given to including IAEA inspectors in the "multinational staff" envisioned by the Experts. Inspectors could play key roles in carrying out or supervising the plant's nuclear material accountancy system. Depending on the tasks that they performed, this direct participation in the operation of the plant might be the best way to enhance the confidence of the IAEA.[viii] Such participation would, undoubtedly, raise legal issues that would have to be resolved. In addition, regardless of the staff, care would have to be taken to protect sensitive technology.

3.2. State Level Approach

The IAEA is transforming its safeguards system from a facility-by-facility approach to a State Level Approach (SLA). In the latter, it views the state as a whole, takes into account all available information, and uses a careful and structured analysis of all aspects of an individual NNWS's nuclear activities and the nuclear weapon materials and technologies acquisition paths available to it that is embodied in the State Evaluation Report (SER). The SLA is based on the state-specific set of objectives that need to be addressed in order to determine the relative level and focus of safeguards activities needed for the Agency to draw soundly-based safeguards conclusions. The SLA is used both to draw safeguards conclusions and to plan inspections.

Whether and how to take into account for these purposes the presence of a multinational facility in a given State is an open question. It may depend on whether the facility was in an "extraterritorial enclave," a possibility suggested in a proposal from Germany. In this case, it would not appear to have a direct bearing on the evaluation of the host state, although the willingness of the state to host the facility could be factored in.

In general, elements that are factored into a State level evaluation include the quality of the SSAC; IAEA's ability to employ safeguards measures such as unattended and remote monitoring or short-notice random inspections (SNRI; and availability of information about the state's nuclear activities. As discussed above, the multinational facility should contribute to the overall transparency of the host State's nuclear activities.

3.3 SLA in a NWS

The fact that the IUEC is in a nuclear weapon state (NWS) provokes the general question of whether there is an applicable state level approach for a NWS, recognizing that State Level Approaches are intended to be applied to NNWS where both a comprehensive safeguards agreement and an Additional Protocol are in force. There they form the basis for drawing conclusions about the absence of diversion from declared nuclear material and of undeclared nuclear material and activities in the State as a whole.

On the other hand, when safeguards are applied in NWS, the safeguards conclusion is narrower --whether or not nuclear material has been removed from a facility other than in accordance with the terms of the relevant agreement. For obvious reasons, there is not, in these cases, any objective of detecting diversion to nuclear weapons.

The technical objective of safeguards is also different in NWS than in NNWS, in particular by being facility specific. Russia's voluntary offer safeguards agreement is typical when it states that the objective of safeguards is the timely detection of the withdrawal of nuclear material from facilities at which safeguards are being applied except in accordance with the terms of the agreement. Conclusions are not, and cannot, be drawn at the State level about the absence of undeclared nuclear activities.

It should be emphasized that developing a SLA for NWS safeguards implementation has not been pursued to date. In addition, safeguards implementation at reprocessing and enrichment plants has not been adapted under integrated safeguards arrangements.[ix] Except for plant specific adaptations, to date IAEA has sought to ensure uniform implementation of safeguards at enrichment and reprocessing facilities.

While the objectives and purposes of safeguards differ, to the extent that safeguards are applied at a multinational facility in a NWS, there are ways that a NWS SLA might be developed. These ways would be additional to whatever consideration would flow from the facility being a multinational enterprise. One way is to take into account in the structured analysis that is referred to above the fact of an existing nuclear weapon program in establishing safeguards priorities. The fact of these programs implies a lack of incentive to "divert" nuclear material from a safeguarded uranium enrichment facility or to produce excess LEU or HEU clandestinely. One way to take this into account would be to use less stringent goals for the inspection parameters of detection probability, timeliness of detection, or significant quantity. For example, a higher SQ might be considered as more appropriate.

One could also review the relevance or the weighting of the three IAEA objectives for enrichment plant safeguards:

- diversion of significant quantities of declared material
- excess production of LEU from undeclared feed
- production of enriched uranium with a greater than declared enrichment, particularly HEU.

Of these, the second might be considered less pertinent than the others for a NWS where it operated at the same time an unsafeguarded uranium enrichment facility that was already producing LEU from "undeclared feed" - undeclared because the plant was not subject to safeguards. In the same vein, the first objective might be considered less pertinent than the third, both because the material would need further processing to manufacture a nuclear weapon and because of the presence of unsafeguarded stocks of similar material.

An alternative way is to adjust safeguards implementation or intensity would be to use factors that were seen as indicators of the commitment of the NWS to fulfill its NPT Article VI obligations. For example, one could take onto account factors such as:

- the status of the nuclear weapon stockpile in a NWS and whether it was growing, was static, or was being reduced; and .
- whether nuclear material from nuclear weapons was being transferred to peaceful uses – downblending of HEU or use of Pu in reactor fuel.

In circumstances where it seemed clear that nuclear weapon stockpiles were diminishing or where nuclear weapon material was being converted to civil use, the priority attached to the third objective – production of HEU – might be reduced.

4. Concluding remarks

There is considerable interest in the use of international or multinational nuclear fuel cycle centers to help stimulate the growth of nuclear energy as a share of global electricity production. However this must be done in a fashion that promotes important nuclear nonproliferation objectives, especially by eliminating the need for states to develop their own sensitive nuclear technologies through assured access to necessary nuclear material. The dissemination of sensitive uranium enrichment technology by the A.Q. Khan clandestine network highlights to importance of this objective.

The Russian Federation has already established one such center that is structured to provide assured access through the combination of a joint stock company that is independent of state budgets; has access to enrichment services via contract with the AECC; and will have, further, a significant reserve of enriched uranium that is to be made available in case of a supply disruption. A key is that assured access is available to countries that do not develop their own uranium enrichment capacities.

Still, there are aspects of the IUEC that remain to be completed, especially, perhaps, the finalization of arrangement with the IAEA providing for the application of safeguards to IUEC nuclear material.

The IUEC is unique, but it calls attention to a number of issues that arise in the context of a multinational fuel cycle center, including some that apply to all such centers and some that apply to centers in a NWS.

It is clear that there remains considerable room for further development of these issues.

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[i] See INFCIRC/640, 22 February 2005, Multilateral Approaches to the Nuclear Fuel Cycle: Expert Group Report submitted to the Director General of the International Atomic Energy Agency

[ii] INFCIRC/708, 8 June 2007, Communication received from the Resident Representative of the Russian Federation to the IAEA on the Establishment, Structure and Operation of the International Uranium Enrichment Centre

[iii] Fact Sheet: Obama's New Plan to Confront 21st Century Threats, Chicago, IL | July 16, 2008 at http://www.barackobama.com/2008/07/16/fact_sheet_obamas_new_plan_to.php

[iv] See INFCIRC/708), 8 June 2007, letter from the Permanent Mission of Russia on the *Establishment, Structure and Operation of the International Uranium Enrichment Centre* (which contained an attachment on *Establishment, structure and operation of the International Uranium Enrichment Centre.*

[v] Development of the Russian Federation Initiative to Establish a Reserve of Low Enriched Uranium (LEU) for the Supply of LEU to the IAEA for its Member States, GOV/INF/2009/1, 23 February 2009, Attachment, Page5.

[vi] IAEA General Conference GC(52)/OR.1, Record of the First Meeting, Austria Center, Vienna, Monday, 29 September 2008, Items: 152-187.

[vii] Not all observers endorse the idea that multinational nuclear arrangements are necessarily positive. In at least one case, a participant in a multinational facility (Iran) was reused access to nuclear material for reasons other than strictly related to nuclear nonproliferation.

[viii] If the MNA reimbursed the IAEA for the work performed by IAEA staff, the total cost to the IAEA would be reduced.

[ix] According to the IAEA's "Research and Development Programme for Nuclear Verification 2006-207," integrated safeguards approaches for uranium enrichment facilities, MOX facilities, reprocessing plants, and HEU storage facilities remained to be "developed, tested, and approved."